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**PACKING ASSEMBLY FOR USE IN A PLUNGER BORE.**

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**EP 0 185 753 B1**

## Description

The invention relates to an improved packing assembly of the type used to prevent fluid leaks around a plunger. In a specific application, the packing assembly is used in plunger-type pumps.

In various well treating operations, such as hydraulic fracturing, fluids are pumped into the wellbore by plunger-type pumps, such as Triplex or Quintuplex pumps. On the suction stroke of the pump, each plunger is pulled along the plunger bore away from the valve chamber. At the end of the suction stroke, the plunger reverses direction and is pushed back along the bore toward the pump chamber, to displace incoming fluid through the outlet valves. Rings of packing material are installed in the plunger bore to prevent the incoming fluid from leaking past the plunger. Each of the packing rings, in cross-section, is shaped like a chevron, and each ring has a central groove on the front side which functions as a hinge. The rear of each packing ring, therefore, has a generally convex shape and the front face is of a generally concave shape. The bottom edge of each packing ring defines a lip which fits snugly against the plunger to provide the liquid-tight seal.

In one form of the packing assemblies now in use, the packing rings are set into the plunger bore in side-by-side relation. This structure is usually referred to as a single stack arrangement and generally includes about four packing rings. In front of the last packing ring in the stack is a metal (brass) female adaptor ring, a lubrication gland, a packing gland spacer, and a packing gland. The front face of the female adaptor ring has a generally concave shape, so that it can seat against the convex-shaped rear face of the first packing ring. Behind the first packing ring in the stack is a brass male adaptor ring. The rear face of the male adaptor ring has a generally convex shape, so that it can seat against the concave-shaped front face of the first packing ring.

Another arrangement of the packing rings is referred to as a double stack. This arrangement usually consists of two packing rings, with a female adaptor ring positioned in front of the last packing ring in the stack, a male adaptor ring positioned behind the first ring in the stack, and a male-female adaptor ring positioned between the two packing rings.

As the plunger moves back and forth in the plunger bore, on the suction and discharge strokes of the pump, the lips of the packing rings drag considerably. The adaptor rings keep the plunger concentric with the bore at the "fluid" end of the pump, and thus concentric with the packing rings. The adaptor rings also help to retain the integrity of the cross sectional dimensions of the packing

rings. The adaptor rings now used in packing assemblies installed on plunger-type pumps have a serious defect which causes a wearing away of these rings, rather than increasing the life of the packing. For example, the concave-shaped front faces on the female adaptor rings now available are formed with a 90 degree angle, and the convex-shaped rear faces on the male adaptor rings are formed with either a 90 degree angle or an angle of 115 degrees. However, the packing rings now available have rear faces formed with an angle of either 110 degrees or 120 degrees, and the front faces of these rings form an angle of 90 degrees.

The difference in the angle of the mating faces on the adaptor rings and the packing rings, makes it impossible to seat the adaptor rings snugly against the packing rings when the packing is installed in the plunger bore. In the packing assemblies now in use, therefore, there are wide gaps between the adaptor rings and the packing rings that allow the rings to wobble. This causes excessive wear on the packing as the plunger moves back and forth in the plunger bore. In some instances, the wear is severe enough to reduce the operating life of the packing to only a few hours.

EP-A-0 102 756 describes a packer assembly with V-shaped packing rings (42, 44). The said rings are designed so as to leave no gap between their matching surfaces.

In the practice of the present invention, the operating life of the packing is considerably improved by providing male and female adaptor rings with faces having an angle that precisely conforms to the corresponding angles formed on the faces of the various conventional packing rings now in use.

The present invention particularly resides in a packing assembly which is installed in the plunger bore of a machine, such as a pump, to provide a fluid-tight seal for the machine, comprising:

a packing gland secured at one end of the plunger bore;

a packing gland spacer positioned adjacent to and in contact with the packing gland;

a lubrication gland positioned adjacent to and in contact with the packing gland spacer;

a separated stack of packing rings which includes at least two packing rings, each packing ring having a front face defining a concave shape, a rear face defining a convex shape, and a groove, defining a concave shape, at the center of the front face;

a female adaptor ring positioned between the lubrication gland and the packing ring stack, the female adaptor ring has a front face with a concave shape, the concave shape defines an angle which conforms to the angle defined by the convex shape of the rear face of the last packing ring in the stack, such that the front face of the female adaptor ring

is firmly seated against the rear face of the last packing ring;

a male adaptor ring positioned in front of the first packing ring in the stack, the male adaptor ring has a rear face with a convex shape, and an integral rib member, with a convex shape, at the center of said rear face, the convex shape of the rear face of the male adaptor ring defines an angle which exactly conforms to the angle defined by the concave shape of the front face of the first packing ring, and the convex shape of the rib member exactly conforms to the concave shape of the groove in the front face of the first packing ring, such that the rear face and the integral rib member of the male adaptor ring are able to seat firmly against the front face and groove, respectively, of the first packing ring, the concave shape of the front face of the female adaptor ring defining an angle of about 90 degrees, and the convex shape of the rear face of the male adaptor ring defining an angle of about 110 degrees to 120 degrees.

Figure 1 is a front elevation view, mostly in section, of a packing assembly of this invention. The packing assembly is shown in its installed position in the plunger bore of a pump, with the packing rings being arranged in a unitary stack structure.

Figure 2 is a front elevation view of another embodiment of a packing assembly of this invention, which is also installed in the plunger bore of a pump. The packing rings in this assembly are arranged in a separated stack structure.

Referring to Figure 1, the drawing illustrates a packing assembly of this invention in which the packing rings are arranged in a unitary stack (referred to in prior packing assemblies as a "single stack"). Numeral 10 refers generally to a housing member in a plunger-type pump having a bore 11. During the suction stroke of the pump, a slidable plunger 12 moves backwardly along bore 11 (to the left in Figure 1), to draw fluid into the pump chamber (not shown). At the end of the suction stroke, plunger 12 reverses direction (to the right in Figure 1) to displace the fluid from the chamber. Between the wall of bore 11 and the outside diameter of plunger 12 is a space, which is occupied by the packing assembly of the invention comprising a packing gland nut 13, which is threaded into the rear end of the bore 11. A packing gland spacer 14, having a shoulder at one end, is positioned against a corresponding shoulder on the packing gland nut. A lubrication gland 15 is positioned against the spacer 14 at one end. The opposite end of gland 15 engages the rear face of a female adaptor ring 16. The front face 16a of the female adaptor ring defines a concave shape. A unitary stack of packing rings 17 is provided in which the rear face of each packing ring 17, which

faces toward the female adaptor ring 16, has a convex shape. The opposite, or front face of each packing ring defines a concave shape. Along the front face of each packing ring is a concave-shaped groove, positioned at the center of the front face. This central groove acts as a hinge to allow the packing ring to bend. The packing rings form a fluid-tight seal between the wall of bore 11 and the outside diameter of plunger 12.

The unitary packing ring stack consists of four (4) rings. It will be understood, however, that the number of rings in the unitary stack can vary according to design calculations and other factors. The packing assembly includes a male adaptor ring 18 which is positioned in front of the first packing ring in the stack. The first packing ring has a front face 18a, which has a concave shape. The male adaptor ring 18 includes an integral rib 18b which is positioned at the center of the rear face and is of a generally convex shape.

The packing rings 17 are fabricated with a front face which defines an angle of either 110 degrees or 120 degrees, and the rear face of each ring defines an angle of 90 degrees. In the practice of this invention, therefore, the female adaptor ring 16 is fabricated such that the concave-shaped front face 16a forms an angle of 90 degrees. This enables the front face 16a of the female adaptor ring to seat firmly against the rear face of the last packing ring in the stack. The male adaptor ring 18 is fabricated such that the convex-shaped rear face 18a describes an angle of 110 degrees, or 120 degrees. In addition, the rib 18b is fabricated as an integral part of the rear face and has a convex shape which exactly conforms to the concave shape of the central groove (the hinge) in the first packing ring 17. The rib 18b on the male adaptor ring, therefore, is a critical part of the present invention, which enables the ring to seat firmly against the front face of the first packing ring. This is a distinct advantage over conventional packing arrangements, which do not have a rib or similar member on the face of the adaptor rings.

Figure 2 illustrates a packing assembly in which the packing rings are arranged in a separated stack structure (also referred to in the prior packing assemblies as a "double stack"). The parts which make up this packing assembly are the same as those used in the packing assembly illustrated in Figure 1, except for a male-female adaptor ring 19, which is not required in the unitary packing ring stack. The parts of the packing assembly in Figure 2 which are identical to those shown in Figure 1 are designated with the same reference numerals.

As shown, the female adaptor ring 16 is positioned between the lubrication gland 15 and the second packing ring 17, such that the concave-

shaped front face 16a seats firmly against the convex-shaped rear face of the second packing ring. The male-female adaptor ring 19 is positioned between the two packing rings 17 which make up the separated stack. The male-female adaptor ring has a rear face 19a with a convex shape. At the center of the rear face is an integral rib member 19b, which has a generally convex shape. The male adaptor ring 18, is positioned in front of the first packing ring in the stack. The adaptor ring 18 also has a rear face 18a, with a convex shape, which includes a convex-shaped integral rib member 18b, located at the center of the face.

The angle defined by the concave-shaped front face 16a of the female adaptor ring 16 (like the adaptor ring 16 illustrated in Figure 1) is 90 degrees, so that the adaptor ring can seat firmly against the rear face of the second ring 17 in the separated stack. The convex-shaped rear face 19a of the male-female adaptor ring 19 defines an angle of 110 degrees, or 120 degrees, and the convex shape of rib 19b matches the central groove in the front face of the second packing ring, so that the adaptor ring can fit tightly against the packing ring. The angle on the concave-shaped front face 19c (like that of the adaptor ring 16), is 90 degrees, so that it conforms to the rear face of the first ring in the stack. The rear face 18a of the male adaptor ring 18 (like the rear face on adaptor 19) is fabricated with an angle of either 110 degrees or 120 degrees, so that it will fit snugly against the front face of the first packing ring.

In the practice of this invention, the adaptor rings are fabricated from brass, but other metal alloys or any material compatible with the environment in which the packing assembly must operate can be used. The unitary stack arrangement of the packing rings is usually employed in a packing assembly when the fluid pressure in the plunger bore is less than about 560 kg/cm<sup>2</sup> (8,000 psi). When the pressure is between about 560 to 1400 kg/cm<sup>2</sup> (about 8,000 to about 20,000 psi), the separated stack arrangement is preferred. Another factor to consider when choosing the separated stack arrangement, is that in this structure there is less packing material (the lips defined along the bottom edges of the packing rings) in contact with the sliding plunger. Since there is less packing material in contact with the moving plunger, the operating life of the packing is usually noticeably longer than is the case in the unitary stack arrangement.

## Claims

1. A packing assembly which is installed in the plunger bore (11) of a machine, such as a pump, to provide a fluid-tight seal for the machine, comprising:

a packing gland (13) secured at one end of the plunger bore;

a packing gland spacer (14) positioned adjacent to and in contact with the packing gland;

a lubrication gland (15) positioned adjacent to and in contact with the packing gland spacer;

a separated stack of packing rings (17) which includes at least two packing rings, each packing ring having a front face defining a concave shape, a rear face defining a convex shape, and a groove, defining a concave shape, at the center of the front face;

a female adaptor ring (16) positioned between the lubrication gland and the packing ring stack, the female adaptor ring has a front face with a concave shape, the concave shape defines an angle which conforms to the angle defined by the convex shape of the rear face of the last packing ring in the stack, such that the front face of the female adaptor ring is firmly seated against the rear face of the last packing ring;

a male adaptor ring (18) positioned in front of the first packing ring in the stack, the male adaptor ring has a rear face with a convex shape, and an integral rib member, with a convex shape, at the center of said rear face the convex shape of the rear face of the male adaptor ring defines an angle which exactly conforms to the angle defined by the concave shape of the front face of the first packing ring, and the convex shape of the rib member exactly conforms to the concave shape of the groove in the front face of the first packing ring, such that the rear face and the integral rib member of the male adaptor ring are able to seat firmly against the front face and groove, respectively, of the first packing ring,

the packing assembly being characterized in that the concave shape of the front face of the female adaptor ring (16) defines an angle of about 90 degrees, and the convex shape of the rear face of the male adaptor ring (18) defines an angle of about 110 degrees to 120 degrees.

2. The packing assembly of Claim 1 characterized in that it includes a male-female adaptor ring (19) positioned between two packing rings in the stack, the male-female adaptor ring having a front face and a rear face, the rear face having a convex shape, and an integral rib member, defining a convex shape, at the center of said rear face, and the front face having a concave shape;

the convex shape of the rear face of the male-female adaptor ring defining an angle

which conforms to the angle defined by the concave shape of the front face of the last packing ring in the stack, and the convex shape of the rib member conforms to the concave shape of the groove in the front face of the last packing ring, such that the rear face and the integral rib member of the male-female adaptor ring are able to seat firmly against the front face and groove, respectively, of the last packing ring in the stack;

the concave shape of the front face of the male-female adaptor ring defines an angle which conforms to the angle defined by the convex shape of the rear face of the first packing ring in the stack, such that the front face of the male-female adaptor ring can seat firmly against the rear face of the first packing ring, and in that

the convex shape of the rear face of the male-female adaptor ring (19) defines an angle of from about 110 degrees to 120 degrees, and the concave shape of the front face of the male-female adaptor ring defines an angle of about 90 degrees.

## Patentansprüche

1. Dichtpackungsanordnung, welche in die Plungerbohrung einer Maschine, beispielsweise einer Pumpe, eingesetzt wird, um eine fluiddichte Abdichtung für die Maschine zu bilden, umfassend: eine Packungsstopfbüchse (13), die an einem Ende der Plungerbohrung befestigt ist; einen Abstandhalter (14) für die Packungsstopfbüchse, die bei und in Anlage an der Packungsstopfbüchse angeordnet ist; eine bei und in Anlage an der Packungsstopfbüchse angeordnete Schmierbuchse; einen getrennten Stapel Packungsrings (17) mit wenigstens zwei packungsrings, wobei jeder Packungsring eine Vorderseite mit einer konkaven Form, eine Rückseite mit einer konvexen Form und eine konkave Form aufweisende Nut in der Mitte der Vorderseite hat; einen eingewölbten Adapterring (16), welcher zwischen der Schmierbuchse und dem Packungsringstapel angeordnet ist, wobei der eingewölbte Adapterring eine Vorderseite mit konkaver Form hat und wobei diese konkave Form einen Winkel bildet, welcher dem von der konvexen Form der Rückseite des letzten Packungsringes im Stapel gebildeten Winkel angepaßt ist, so daß die Vorderseite des eingewölbten Adapterringes fest auf der Rückseite des letzten Packungsringes sitzt; einen vorgewölbten Adapterring (18), welcher vor dem ersten Packungsring im Stapel ange-

ordnet ist, wobei der vorgewölbte Adapterring eine Rückseite mit einer konvexen Form und ein damit integrales Rippenelement mit einer konvexen Form in der Mitte der Rückseite hat, wobei ferner die konvexe Form der Rückseite des vorgewölbten Adapterringes einen Winkel bildet, welcher exakt an den von der konkaven Form der Vorderseite des ersten Packungsringes gebildeten Winkel angepaßt ist, und wobei die konvexe Form des Rippenelementes exakt an die konkave Form der Nut in der Vorderseite des ersten Packungsringes angepaßt ist, so daß die Rückseite bzw. das integrale Rippenelement des vorgewölbten Adapterringes fest an der Vorderseite bzw. der Nut des ersten Packungsringes anliegen können, wobei die Dichtpackungsanordnung dadurch **gekennzeichnet** ist, daß die konkave Form der Vorderseite des eingewölbten Adapterringes (16) einen Winkel von etwa 90° bildet und daß die konvexe Form der Rückseite des vorgewölbten Adapterringes (18) einen Winkel von etwa 110° bis 120° bildet.

2. Packungsanordnung nach Anspruch 1, dadurch **gekennzeichnet**, daß sie einen vor- und eingewölbten Adapterring (19) hat, der zwischen zwei Packungsringen im Stapel angeordnet ist, wobei dieser vor- und eingewölbte Adapterring eine Vorderseite und eine Rückseite hat, von denen die Rückseite eine konvexe Form sowie ein integrales Rippenelement mit einer konvexen Form in der Mitte der Rückseite, die Vorderseite jedoch eine konkave Form aufweist; daß ferner die konvexe Form der Rückseite des vor- und eingewölbten Adapterringes einen Winkel bildet, welcher an den von der konkaven Form der Vorderseite des letzten Packungsringes im Stapel gebildeten Winkel angepaßt ist, und wobei die konvexe Form des Rippenelementes an die konkave Nut in der Vorderseite des letzten Packungsringes angepaßt ist, so daß die Rückseite bzw. das integrale Rippenelement des vor- und eingewölbten Adapterringes fest an der Vorderseite bzw. der Nut des letzten Packungsringes im Stapel anliegen können; daß die konkave Form der Vorderseite des vor- und eingewölbten Adapterringes einen Winkel bildet, welcher an den von der konvexen Form der Rückseite des ersten Packungsringes im Stapel gebildeten Winkel angepaßt ist, so daß die Vorderseite des vor- und eingewölbten Adapterringes fest an der Rückseite des ersten Packungsringes anliegen kann; und daß die konvexe Form der Rückseite des vor- und eingewölbten Adapterringes (19) einen Winkel von etwa 110° bis 120° bildet und die konkave Form der Vorder-

seite des vor- und eingewölbten Adapterringes einen Winkel von etwa 90° bildet.

## Revendications

1. Un ensemble de presse-étoupe qui est installé dans l'alésage (11) de plongeur d'une machine, par exemple une pompe, pour constituer pour la machine un joint étanche aux fluides, comprenant :
- un chapeau (13) de presse-étoupe fixé à une extrémité de l'alésage de plongeur ;
  - une entretoise (14) de chapeau de presse-étoupe positionnée près du chapeau de presse-étoupe et en contact avec lui ;
  - une bague de lubrification (15) positionnée près de l'entretoise de chapeau de presse-étoupe et en contact avec elle ;
  - une pile séparée de bagues (17) de presse-étoupe qui comprend au moins deux bagues de presse-étoupe, chaque bague de presse-étoupe comportant une face avant définissant une forme concave, une face arrière définissant une forme convexe, et une gorge, définissant une forme concave, au centre de la face avant ;
  - une bague adaptatrice femelle (16) positionnée entre la bague de lubrification et la pile de bagues de presse-étoupe, la bague adaptatrice femelle comportant une face avant de forme concave, la forme concave définissant un angle qui est conforme à l'angle défini par la forme convexe de la face arrière de la dernière bague de presse-étoupe de la pile, de façon que la face avant de la bague adaptatrice femelle soit fermement appliquée contre la face arrière de la dernière bague de presse-étoupe ;
  - une bague adaptatrice mâle (18) positionnée face à la première bague de presse-étoupe de la pile, la bague adaptatrice mâle comportant une face arrière de forme convexe, et un élément de nervure d'un seul tenant de forme convexe, au centre de ladite face arrière, la forme convexe de la face arrière de la bague adaptatrice mâle définissant un angle qui est exactement conforme à l'angle défini par la forme concave de la face avant de la première bague de presse-étoupe, et la forme convexe de l'élément de nervure étant exactement conforme à la forme concave de la gorge dans la face avant de la première bague de presse-étoupe, de sorte que la face arrière et l'élément de nervure d'un seul tenant de la bague adaptatrice mâle peuvent s'appuyer fermement contre la face avant de la gorge, respectivement, de la première bague de presse-étoupe,

l'ensemble de presse-étoupe étant caractérisé en ce que la forme convexe de la face avant de la bague adaptatrice femelle (16) définit un angle d'environ 90 degrés et la forme convexe de la face arrière de la bague adaptatrice mâle (18) définit un angle d'environ 110 degrés à 120 degrés.

2. L'ensemble de presse-étoupe selon la revendication 1 caractérisé en ce qu'il comprend une bague adaptatrice mâle-femelle (19) positionnée entre deux bagues de presse-étoupe de la pile, la bague adaptatrice mâle-femelle comprenant une face avant et une face arrière, la face arrière étant de forme convexe, et un élément de nervure d'un seul tenant, définissant une forme convexe, au centre de ladite face arrière, et la face avant étant d'une forme concave ;

la forme convexe de la face arrière de la bague adaptatrice mâle-femelle définissant un angle qui est conforme à l'angle défini par la forme concave de la face avant de la dernière bague de presse-étoupe de la pile, et la forme convexe de l'élément de nervure est conforme à la forme concave de la gorge de la face avant de la dernière bague de presse-étoupe, de sorte que la face arrière et l'élément de nervure d'un seul tenant de la bague adaptatrice mâle-femelle peuvent s'appliquer fermement contre la face avant et la gorge, respectivement de la dernière bague de presse-étoupe de la pile ;

la forme concave de la face avant de la bague adaptatrice mâle-femelle définissant un angle qui est conforme à l'angle défini par la forme convexe de la face arrière de la première bague de presse-étoupe de la pile, de sorte que la face avant de la bague adaptatrice mâle-femelle peut s'appuyer fermement contre la face arrière de la première bague de presse-étoupe, et en ce que

la forme convexe de la face arrière de la bague adaptatrice mâle-femelle (19) définit un angle d'environ 110 degrés à 120 degrés, et la forme concave de la face avant de la bague adaptatrice mâle-femelle définit un angle d'environ 90 degrés.

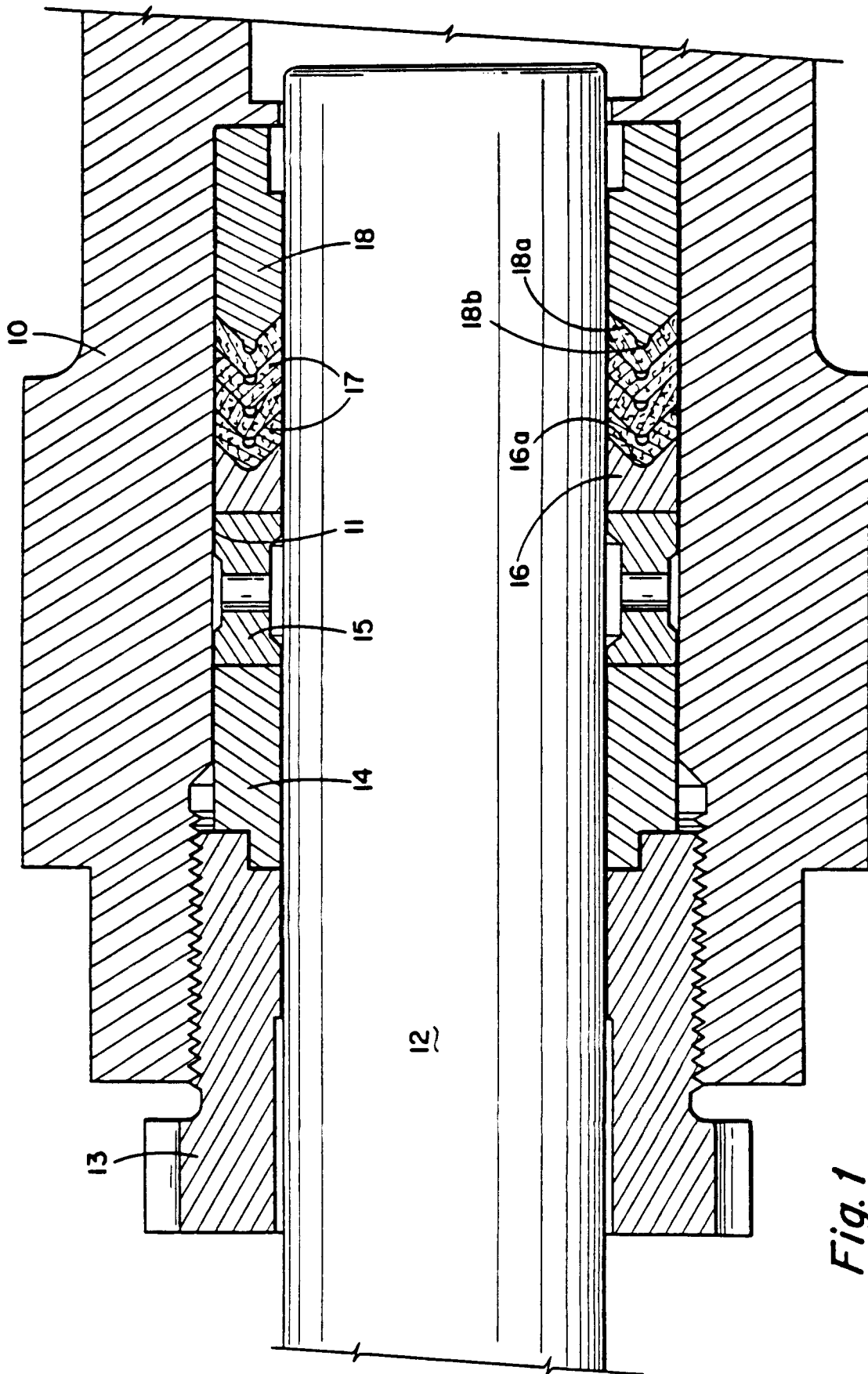


Fig. 1

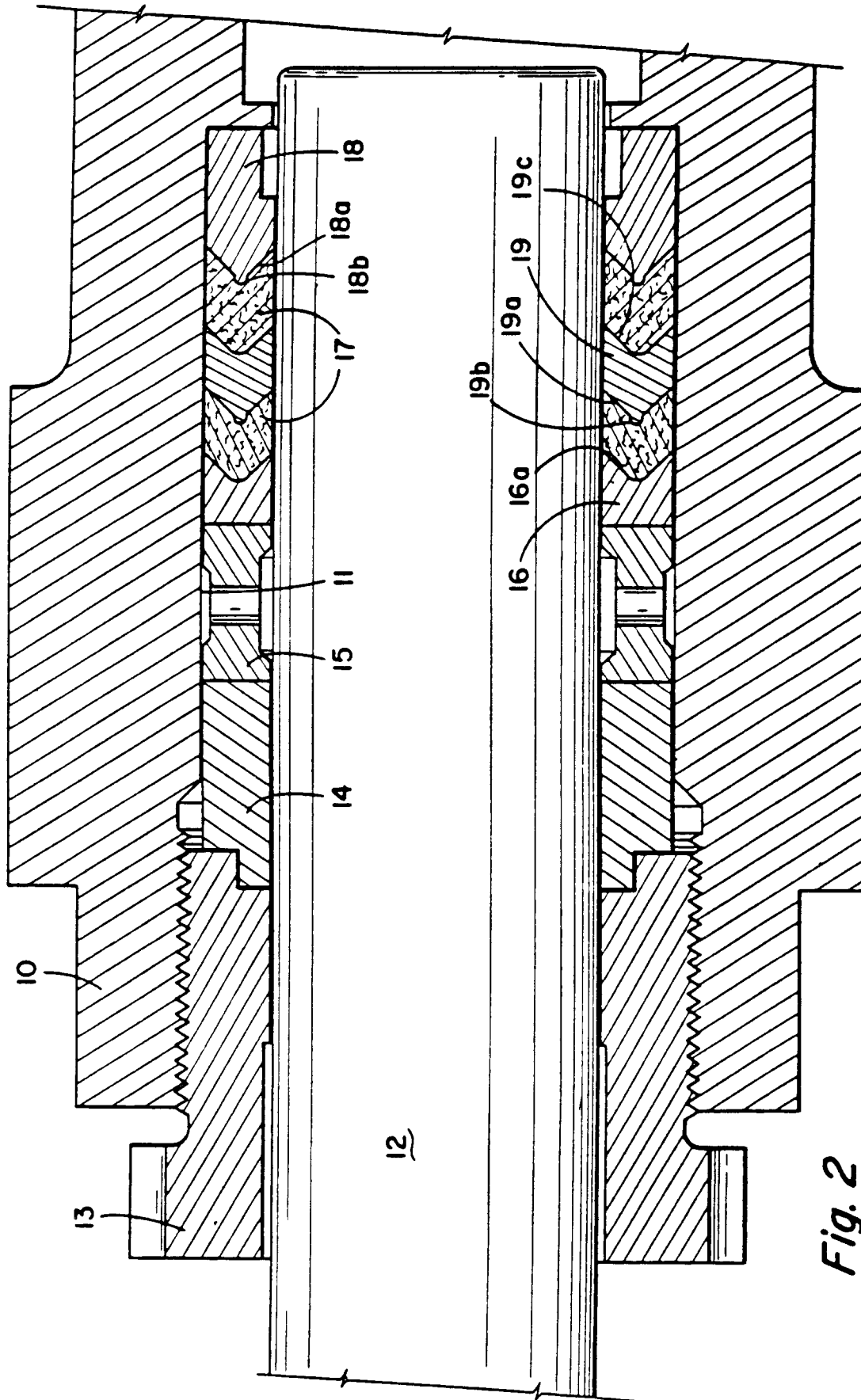


Fig. 2